

PSYCHE.

THE DISTRIBUTION OF HOLARCTIC COLLEMBOLA.

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No less than one hundred and fifty-two species of Collembola are known to occur in North America, of which thirty-eight, at least, are shared with Europe. Their specific identity has been established, not simply from descriptions, but by a thorough comparison of specimens. Twenty-five per cent of the Nearctic species, then, are also Palaearctic. Specimens of the latter, as a rule, average slightly larger than of the former, but that is all.

I doubt if as large a proportion of Holarctic species is recorded for any other order of animals; moreover, this proportion is increasing, with the comparison of additional specimens.

Apparently restricted to the eastern part of the United States are several species which may have been recently introduced; such are *Neanura muscorum*, *Aphorura armata*, *Orchesella cincta*, *Sira buski*, *Tomocerus vulgaris* and *tridentiferus*.

The following occur abundantly throughout Europe and the United States: *Aphorura incermis*, *Podura aquatica*, *Achorutes armatus*, *Isotoma fimetaria*,

viridis and *palustris*, also *Entomobrya multifasciata*. These are the more obtrusive members of the order and, having been widely collected, furnish valuable data for the study of distribution. The list will doubtless be increased when more is known about the Collembola of the western states; as it is, the forms next named, which range throughout Europe, are known to occur in most of the States east of the Rocky Mountains: *Anurida granaria*, *Isotoma cinerea*, *Lepidocyrtus cyaneus*, *Sira nigromaculata*, *Sminthurus aquaticus*, *malmgreni*, *hortensis* and *elegans*.

In the arctic regions the less specialized Collembola flourish, some species becoming larger than in middle Europe. Thanks to several expeditions, our knowledge of the arctic range of many species is definite. Of the sixty known species of arctic and subarctic Collembola, at least twenty are broadly distributed in the United States, and all but a few occur in northern and middle Europe; in fact, but three or four are peculiar to the arctic region.

In Greenland, Spitzbergen, Franz

Josef Land, Nova Zembla, Siberia and Alaska are found many of the species common to Europe and the United States, for example, *Neanura muscorum*, *Anurida granaria*, *Achorutes armatus*, *Isotoma palustris* and *viridis*. Hitherto, *Tomocerus niger* of Europe, *T. arcticus* of Siberia and *T. americanus* of California have been regarded as distinct species. The Harriman expedition, however, brought from Alaska numerous specimens which form perfect intergradations between the three forms named.

There is, then, not only a remarkable agreement in structure between European and North American Collembola, but also, for many species, continuity of distribution.

The specific identity of so many Holarctic species, an identity which would not be expected upon *a priori* grounds, may easily be accounted for. The Collembola and Thysanura, the most generalized of hexapods, present very few adaptive characters as contrasted with other insects. The Collembola feed upon organic debris and are mostly confined to moist and decaying vegetable matter or to water surfaces. Like the worms, the simplicity of their external organization is to be attributed to the uniformity of their environment. The simple conditions of food, moisture, temperature, etc., which a Collembolan requires, may be found almost anywhere in the Holarctic region; so that, after all, it is difficult to understand how, under such circumstances, any decided modi-

fication of even varietal value could occur. The species of continuous Holarctic distribution are, in every case, only such as can exist in a comparatively simple environment, — the more specialized species and genera are not found to any extent in the arctic region.

The wide distribution of Collembola is surprising, for they appear to have no means of self dispersal; they lack wings and probably always did, as none are found in the embryo; their feeble walking and leaping could procure only a limited local distribution; a dry spot is an effective barrier to most Collembola, which require an atmosphere saturated with moisture. The insects may possibly be blown about to some extent, but their eggs are probably not, as they are laid in the soil, under bark, or in other concealed places.

As for accidental means of dispersal, there may be many. Several species not indigenous have been found in green-houses among exotic plants. *Isotoma fimetaria*, abundant in rich soil, frequently occurs on potted plants. I used to find *Entomobrya multifasciata* and other species among early strawberries which had been brought to Massachusetts from the south. The influence of man, then, in transporting Collembola upon plants, fruits or vegetables is not inconsiderable.

The lower animals perhaps assist now and then. Moniez found a species of *Entomobrya* by hundreds in the fresh nest of a finch, where they were feeding upon the lining of feathers: Wahlgren

records three species of Collembola from the mossy nests of sea gulls; whether birds carry these insects among their feathers, or not, is not known. Mr. S. R. Williams gave me a specimen of *Entomobrya griseo-olivata* and a Thrips both of which he found deep in the fur of a mole.

These accidental, or occasional, means of dispersion may be recognized without being assigned too much importance. Certainly, human intervention cannot be held responsible for the distribution of the arctic forms by which the European and North American faunae are linked together.

By far the most important agent of dispersion is running water. During most of the year, some species of Collembola are to be found on our streams and ponds and, in some months, as many as a dozen kinds at once. A few of these, such as *Podura aquatica*, *Isotoma palustris*, *Sminthurus aquaticus*, *malmgreni* and *spinatus* possess structural adaptations for their semiaquatic life, but many other species are met with which, though normally terrestrial, are quite at home on the surface of fresh water, which cannot wet them, and in which they cannot sink; they leap upon the surface film with ease.

Such species undoubtedly owe their broad distribution mainly to streams of fresh water.

The snow fleas, which attract interest by their sudden appearance in immense numbers, are distributed by the same means. In the latter part of winter

they may be found, more or less benumbed, under the loose bark of trees, especially pine, oak and maple, or else about the roots among dead leaves, in which situations their eggs are laid. Rendered active by the first warmth of spring, the little creatures wander out and sometimes darken the snow by their numbers. Rivulets of melted snow or of rain water carry them to the brooks whence they are borne to the rivers and scattered no one knows how far.

Many other species are washed from stream to stream in the same way; floating logs, branches and roots must often transport Collembola, especially of the genus *Isotoma*, a large proportion of which live under loose bark. In fact, I believe that the most important agents of dispersion for inland Collembola are fresh water streams.

Marine currents, also, are of vast importance in this respect. Wahlgren records nine species of Collembola from barren rocky islands off the Swedish coast and properly maintains that they were distributed solely by sea water. These are *Anurida maritima* and *tullbergi*, *Anurophorus laticis*, *Xenylla maritima* and *humicola*, *Achorutes viaticus*, *Isotoma viridis*, *Entomobrya lanuginosa* and *Sira huski*.

It is a significant fact that almost all those named are Holarctic.

The species of *Anurida*, indeed, are restricted to salt water. *A. maritima* is common on the coast of Massachusetts, where it occurs in colonies between tide marks. At low tide the insects walk

about and feed upon dead mollusks; as the tide rises they hide under stones and become submerged.

Now this species occurs not only on the coasts of New England, Long Island, Florida, and probably of intervening places, but also along the entire western coast of Europe; its distribution by marine currents, therefore, cannot be doubted.

Isotoma besselsi, a marine species found first at Polaris Bay, is not rare on the coast of Massachusetts and has lately been found in Spitzbergen. *Xenylla humicola* has a similar distribution.

Achorutes tullbergi (*dubius* Tull.) inhabits Siberia, Nova Zembla, Franz Josef Land and Spitzbergen, and also occurs on the salt marshes of eastern Massachusetts.

Achorutes viaticus not only ranges over the Palaearctic region, including the arctic islands, but has been found in California and even in Tierra del Fuego.

Finally, *Achorutes armatus*, which occurs throughout the Holarctic region, has been taken in South America, New Zealand and Sumatra.

More cosmopolitan forms are known, but none of the other faunal regions share their species to the extent to which the Palaearctic and Nearctic do.

I have shown that a number of generalized species of Collembola inhabiting

both Europe and the United States are practically continuous in their distribution between the two places. The fact, however, that most Holarctic species are discontinuous must be accounted for and the explanation of the fact is important for its general bearing.

Nearly all the Holarctic species of the Arctic regions proper belong to the most generalized families, i. e., Aphoruridae and Poduridae, and can live in an environment of extreme simplicity and rigor, needing but the scantiest of vegetation and being quite tolerant of cold; in temperate regions they are noticeably the most active species of the order during the winter.

The Entomobryidae and Sminthuridae, on the other hand, require more warmth and certainly a more luxuriant vegetation than arctic regions afford. Now these most specialized families, adapted to a more complex environment, contain many species which, although identical in middle Europe and the United States, do not exist, it may safely be said, in the intervening regions, where, most probably, they formerly must have occurred. The inference is obvious, then, that a higher temperature and a more luxuriant vegetation than at present once prevailed in the arctic zone. This is no news, of course,—but the additional evidence is worth something.